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# Review of the biology and host plants of the Australian jewel beetle *Agrilus australasiae* Laporte & Gory

## (Coleoptera: Buprestidae)

By **Trevor J. Hawkeswood**

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The biology and host plants of the Australian jewel beetle, *Agrilus australasiae* Laporte & Gory (Coleoptera: Buprestidae: Agrilinae) are reviewed both from the literature and previously unpublished observations. The species is often common in a variety of habitats in eastern Australia – e. g. low open woodlands and heathlands to dry sclerophyll forests. The known larval host plants are *Acacia pycnantha* Benth. and *A. sophorae* (Labill.) R. Br. (Mimosaceae) while the known adult food plants are *Acacia dealbata* Link, *A. decurrens* (Wendl.) Willd., *A. parramattensis* Tindale and *A. sophorae* (Labill.) R. Br. (Mimosaceae). Adults appear to be mainly foliage feeders. Various ecological characteristics of the beetle, such as the ability to occupy highly seasonal regions, general spatial patchiness of resident populations within a region, dispersal ability of adults, habitat selection, colonizing ability, abundance of food plants, predation, escape mechanisms, cryptic coloration and sex ratio of adult beetles in random collections, are all reviewed and discussed.

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## Introduction

The Grey-striped Agrilus, *Agrilus australasiae* Laporte & Gory (Fig. 1) (Coleoptera: Buprestidae: Agrilinae) is a small bronze-copper coloured beetle with white/cream stripes and other marks on the lateral margins of the body and appears restricted to eastern Australia. Although it is perhaps the most common member of the genus in Australia, little has been recorded on its biology and behaviour. Recent field observations and collections by the present author have prompted a review on the species biology, behaviour and host plants.

## Review of previously published biological data

Froggatt (1902: 702; 1923: 106) was the first to record biological data on the species; he noted that adults of *A. australasiae* were plentiful upon the foliage of *Acacia decurrens* (Wendl.) Willd. (Mimosaceae) but did not indicate whether or not the beetle bred in the wattle. Froggatt (1902, 1923) further noted that adults could be collected from the wattle foliage in the Mittagong district, New South Wa-

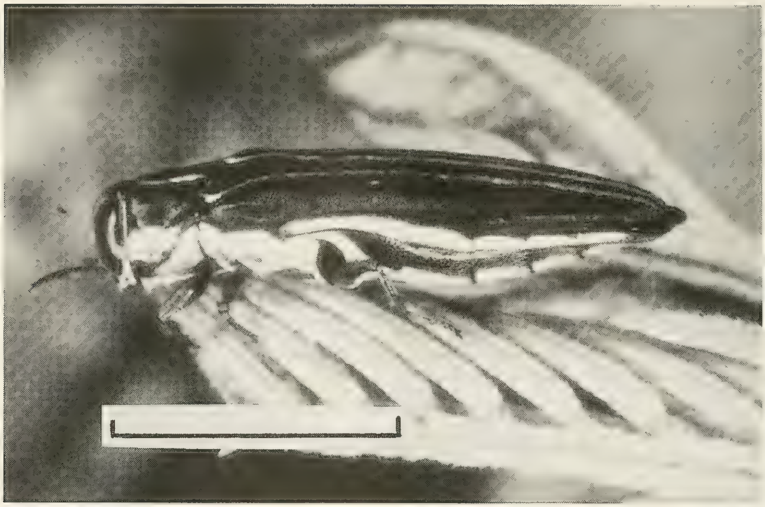

Fig. 1. Adult female of *Agrilus australasiae* Laporte & Gory on the bipinnate foliage of an unidentified *Acacia* sp. near Legume, New South Wales. Scale line = 5 mm. (Photo: D. G. Knowles, from Hawkeswood, 1987).

les, by shaking the branches of the tree into a net or umbrella. Gurney (1911: 58) recorded *A. australasiae* as associated with wattle trees *(Acacia* spp.) but did not specifically record any hosts. Froggatt (1927: 14) noted that one specimen of *A. australasiae* was bred from a dead stem of *Acacia pycnantha* Benth. which formed part of a small experimental plantation of introduced trees near Wee Waa, New South Wales. Nothing was written on the biology of the beetle for over 50 years until Hawkeswood (1981: 148–151) provided the most detailed observations up to that time on the biology and behaviour of *A. australasiae.* Hawkeswood (1981) found that the beetle was one of three buprestids inhabiting foliage of non-flowering *Acacia sophorae* (Labill.) R. Br. bushes growing abundantly on the sand dunes of central coastal New South Wales; *A. australasiae* was present in much smaller numbers than *Cisseis scabrosula* Kerremans, the other species noted by Hawkeswood (1981) and usually occupied small *Acacia* plants 0.3–0.4 m high; a total of 16 occurrences of escape behaviour were recorded (Hawkeswood, 1981: 148–149); of these 11 occurrences (68.8% of the total) comprised "upward flight" while 5 occurrences (31.2%) comprised thanatosis; a total of 23 beetles were counted from 12 plants, giving an average of 1.9 beetles/plant at any one time; adults fed extensively on *A. sophorae* leaves in the laboratory; Hawkeswood (1981: 151) finally mentioned that *A. australasiae* occupied a habitat which was restricted to a narrow zone on the sand dunes adjacent to the ocean, that it was possible that *A. sophorae* was the only plant species which the beetles utilized for food and breeding purposes in the Coffs Harbour area, New South Wales, and since *A. australasiae* appeared restricted to *A. sophorae* along the dunes, any future disturbances to this habitat such as clearing of dunes for residential development, could lead to their extinction in these areas. Van den Berg (1982: 51) briefly noted that an adult of *A. australasiae* was found feeding on a leaf of *Acacia dealbata* Link but failed to provide locality data and other details for this record, nor referred to any previously published references for the beetle. Williams & Williams (1983: 84) recorded two adult host plants (one of which, *Acacia decurrens* (Wendl.) Willd. was previously recorded by Froggatt (1902, 1923) from the Sydney district, New South Wales. Hawkeswood (1987) provided brief notes on biology and distribution as well as providing the first colour photograph of the beetle. Volkovitsh & Hawkeswood (1990) have more recently described the larva/prepupa of *A. australasiae* from material collected from the dead wood of *Acacia sophorae* (Labill.) R. Br. at Hastings Point, northeastern New South Wales. A summary of the host data and original references is provided in Table 1.

Table 1. Summary of larval and adult host plants, locality and habitat data and original references for *Agrilus australasiae* Laporte & Gory

| Host plant species | Larval (L) or Adult (A) host plant | Locality | Habitat* | Reference |
|---|---|---|---|---|
| *Acacia dealbata* Link | A | (?) | (?) | Van den Berg (1982) |
| *Acacia decurrens* (Wendl.) Willd. | A | Mittagong, NSW | (?) | Froggatt (1902, 1923) |
| | A | Waterfall, NSW | DSF/LOW | Williams & Williams (1983) |
| | A | Royal National Park, NSW | DSF/LOW | Williams & Williams (1983) |
| | A | Middle Dural, NSW | DSF | Williams & Williams (1983) |
| | A | Maroota, NSW | DSF | Williams & Williams (1983) |
| | A | Lapstone Hill, lower Blue Mts, NSW | DSF | Williams & Williams (1983) |
| | A | Mt. Boyce, upper Blue Mts, NSW | MW | Williams & Williams (1983) |
| *Acacia parramattensis* Tindale | A | Middle Dural, NSW | DSF | Williams & Williams (1983) |
| *Acacia pycnantha* Benth. | L | Near Wee Waa, NSW | CW | Froggatt (1927) |
| *Acacia sophorae* (Labill.) R.Br. | A | Mylestom Beach, NSW | SH/BW | Hawkeswood (1981) |
| | A | Hungry Head, NSW | SH/BW | Hawkeswood (1981) |
| | L | Hastings Point, NSW | SH/BW | Volkovitsh & Hawkeswood (1990) |

* CW = Closed woodland (= "pilliga scrub"); DSF = Dry sclerophyll forest; DSF/LOW = Dry sclerophyll forest merging to low open woodland; MW = Mallee dominated woodland; SH/BW = Sand dune habitat merging into *Banksia* woodland

## Further observations

During examinations of dead plants for wood borers on sand dunes in the Pottsville-Hastings Point area of north-eastern New South Wales during 1987–1990, larvae and dead/live adults of *A. australasiae* were extracted from the dead branches of *Acacia sophorae* (Labill.) R. Br. (Mimosaceae). The size of the infested dry wood ranged from 20–25 mm in diameter and was often broken off partially living plants. From an examination of this wood, it was apparent that (a) eggs are laid in small fissures in the bark (probably of dead or dying branches and sometimes near the base of the plant); (b) the young larvae bore into the cork cambial region of the wood immediately below the bark and above the sapwood where they feed for some time, chewing out extensive, shallow channels and compacting the frass behind them as they proceed; (c) usually the smaller branches and stems less than 20 mm diameter are not attacked by *A. australasiae;* (d) at a later stage, the larvae bore further down into the sapwood where they chew longitudinal channels parallel with the grain of the wood and the frass is also

Table 2. Summary of the major ecological characteristics[A] of *Agrilus australasiae* Laporte & Gory (Buprestidae: Agrilinae)

| Phenotypic and other characters responding to selection | Determined and/or predicted[B] character states |
|---|---|
| 1. Geographical range | Widespread |
| 2. Local endemism and restriction of gene flow | Low* |
| 3. Distribution across marked elevational gradients | Moderate to high |
| 4. Ability to occupy highly seasonal regions | Good |
| 5. General spatial patchiness or resident populations over approx. 1.000 metre sections of a region | High |
| 6. Dispersal ability of adults | Low to moderate* |
| 7. Intrapopulational variation | Low |
| 8. Interpopulational variation | Low to moderate |
| 9. Habitat selection | Generalized (low) grading into specialized (high) |
| 10. Main habitat | Sand dune heathlands and surrounding open or closed woodlands |
| 11. Colonizing ability | Moderate to high |
| 12. Local population density | High |
| 13. Regional breadth of larval food plants | Low |
| 14. Relative abundance of larval food plants per unit area of suitable habitat | High |
| 15. Oviposition strategy | Multiple and restricted* |
| 16. Oviposition proneness in captivity | Unknown |
| 17. Predation/parasitism on immature stages | Low to moderate |
| 18. Overall fecundity (average per female) | Moderate to high* |
| 19. Egg-adult development time | 1–2 years* |
| 20. Activity of adults | Diurnal |
| 21. Escape mechanisms | Well developed |
| 22. Cryptic coloration | Well developed |
| 23. Sex ratio of adults in random collections | Skewed males |
| 24. Diurnal rhythmicity of adult feeding | Probably not present* |

A = Adapted and modified from Young (1982) for butterflies; B = Character states marked with an asterisk are predictions compacted behind them as they feed and is not extruded through exit holes; (e) upon cessation of feeding, the larva constructs a pupal cell, often situated 2–5 mm below the level of the outer bark layer; (f) pupal cells are also situated parallel to the longitudinal axis of the branch and the head of the beetle is positioned at the highest end; (g) adults spend at least a week in the pupal cell before emerging through the bark via a distinctive semi-circular exit hole measuring 1.8–2.2 mm in diameter; (h) emergence of adults can be as early as late August or early September during favourable years; (i) a sample of 8 pupal cells were measured, giving the following data (length measurements are provided first and then the corresponding widths, measured at the widest point, of the pupal cells; both length and width measurements are provided in mm) – 12.0, 13.5, 15.0, 15.5, 17.0, 18.0, 20.0, 20.5 (Mean $\pm$ SD = 16.4 $\pm$ 3.0 mm) and 1.8, 2.6, 2.1, 1.8, 2.5, 2.0, 2.2, 2.7 (Mean $\pm$ SD = 2.2 $\pm$ 0.4 mm); (j) density of exit holes on infested branches, stems and trunks of *A. sophorae* ranged from 10–20 holes/100 $cm^2$ of bark surface; (k) extensive dissections of dead, infested branches and trunks of *A. sophorae* yielded larvae and adults of at least two species of *Ancita* (Coleoptera: Cerambycidae: Lamiinae), larvae of an unidentified species of Trogossitidae (Coleoptera) (probably *Leperina cirrosa* Pascoe), adults of *Menephilus colydioides* Macleay (Coleoptera: Tenebrionidae) and larvae, pupae and adults of a presently unidentified species of Tenebrionidae.

Examinations of *Acacia* plants during the early morning and evening were undertaken when temperatures were cooler ($\leq$22° C); adults were usually observed resting near the base of the leaves or on the main stems and upper branches near foliage where they were well camouflaged. From 2–10 beetles/plant at any one time were counted. Oviposition was not observed. Observations indicated that beetles were common on certain *A. sophorae* plants only and that adults were not found on most *A. sophorae* plants in the area. During 1987–1990, a total of 105 adults were collected and their sex noted (62 ♂♂ and 43 ♀♀). The only predator of adults observed in the field during the observation periods was *Araneus transmarinus* (Keyserling) a common net-building spider in the area.

## Discussion

A summary of the major ecological characteristics of *Agrilus australasiae* are provided in Table 2. An explanation and discussion of these characteristics is provided here. The distribution of *A. australasiae* is listed as widespread; for Australian species, I will define here a widespread species as one which occurs over a distance of 1.000 km or more. Carter (1929) listed the distribution of *A. australasiae* as Queensland, New South Wales, Victoria, South Australia and Western Australia, but all of the published biological data has been recorded from populations of the beetle in New South Wales. Because of its widespread distribution, *A. australasiae* is clearly not a local endemic and because of this, there is probably a low natural resistance of gene flow between populations. The effect of clearing and residential development upon gene flow between populations is unknown at present but in the future may be very restrictive. The species presently displays a moderate to high propensity to be distributed over marked elevational gradients, i. e. in New South Wales, it has been recorded from coastal districts at or near sea level (Hawkeswood, 1981 and the present paper) as well as montane areas such as Mt. Boyce in the higher Blue Mountains (Williams & Williams, 1983) at an altitude of approx. 1250 m. The ability of this buprestid to occupy highly seasonal regions is good; e. g. in the Blue mountains during summer, average daily temperatures range from 25° C to 35° C, while average daily winter temperatures range from −5° C to 15° C. The temperature regimes are more equitable in the subtropical areas of north-eastern New South Wales (in the northern part of the beetle's range) but winter temperatures in these areas can still drop to 0° C during the winter months (June to August). From my observations of *A. australasiae* at Mylestom Beach and Hungry Head (Hawkeswood, 1981) and at Pottsville-Hastings Point (some 270 km north of the two former localities examined) it was revealed that populations of *Agrilus* were confined to certain plants or small groups of plants while intervening trees appeared not to be utilized by *A. australasiae* either for food or resting/mating sites. The dispersal ability of adults is not known for certain at the present time but it must be at least 0.5–1.0 km. This view is derived from the fact that in the Hastings Point area, large portions of the sand dunes were completely denuded of vegetation by sand mining operations during the 1970's and the early 1980's and later the mining companies planted large, almost monospecific stands of such species as *Leptospermum attenuatum* Sm. (Myrtaceae), *Casuarina equisetifolia* L. (Casuarinaceae) and *Acacia sophorae* (Labill.) R. Br. and other native species in the previously denuded areas. Since *A. australasiae* is now well established in these monospecific stands (at least those containing *Acacia)* it can be concluded that the beetle has colonized these areas from other breeding grounds containing *A. sophorae* that were not disturbed by sand mining. These range from 0.5 to about 1.0 km distance from the mined areas.

There appear to be little or no intra- and inter-populational variation for the species, although further detailed studies of museum specimens and freshly collected adults throughout the range of the species may disprove my statements. As noted earlier, during 1987–1990 I collected 105 adults of *A. australasiae* (62 ♂♂ and 43 ♀♀); from this material it was evident that there was little or no intrapopulational variation even in colour pattern. (The females tended to be larger than the males and there were more males in the samples than females.) The habitats occupied by *A. australasiae* range from man-made *Leptospermum-Acacia* heathlands (e. g. in the Hastings Point area, NSW) which have a low diversity of plant species to woodlands and dry sclerophyll forests (e. g. Blue Mountains, NSW) which are much more diverse in terms of plant taxa. The main habitat so far reported for *A. australasiae,* at least in New South Wales, is coastal sand dune heathlands (either natural or man-made) which merge into the surrounding *Banksia* or *Eucalyptus* open or closed woodlands. As noted above, there appears to be some evidence that *A. australasiae* is an efficient colonizer of disturbed habitats which contain suitable host plants; in these habitats, a high local population density may be maintained. Although only two larval host plants have been recorded in the 150 years since the insect was first described (both records of *Acacia pycnantha* Benth. and *A. sophorae* [Labill.] R. Br. are from New South Wales), the abundance of these two *Acacia* species is usually high which is perhaps one reason to account for the high population densities and widespread distribution of the beetle. The oviposition strategy of females is most likely multiple and restricted, i. e. the females each lay a large number of eggs on one plant or on a small group of plants in the one area during the reproductive season. Examinations of branches and stems of *A. sophorae* in the Hastings Point area has indicated that infested stems, branches and trunks showed clustered groups of 10–20 *Agrilus* exit holes in the one small area (e. g. 100 $cm^2$) of the bark. This indicates (a) that larvae probably originated from eggs laid by a female during one oviposition period, and (b) that the larvae do not move large distances throughout the wood of a plant. The oviposition proneness of the beetle is not known since the species has not yet been successfully bred in captivity.

The incidence of predation/parasitism on immature stages is probably low; the only predacious species encountered in the wood was a Trogossitidae (Coleoptera), the larvae of which were in very low numbers and which probably also prey more extensively on the cerambycid larvae *(Ancita* spp.) which were usually more common in the dead *Acacia* wood than *Agrilus.* The main predators of *A. australasiae* adults in the Hastings Point-Pottsville area appear to be net-building spiders, *Araneus transmarinus* (Keyserling) (Araneidae). Escape mechanisms and cryptic coloration appear to be well developed. Presumably these have developed as a response to predation pressures by birds and/or other vertebrate predators but further field observations are needed to determine whether these two characteristics are effective in reducing predation. Moore and Brown (1985) investigated the chemical "bitter principles" of some Australian Buprestidae and found that for *A. australasiae,* these chemicals were present in very weak concentrations (i. e. $< 10\,\%$ of average) in the beetle body, while in other buprestids, e. g. *Stigmodera* spp., the chemicals were well developed and gave strong results in their chemical tests. This suggests that predators such as birds and spiders would probably not be affected by these so-called "bitter principles" when feeding on freshly caught *A. australasiae.* In addition, no specimens of *A. australasiae* caught by me ever exuded brightly-coloured gut secretions/solutions through the mouth when handled as do other Buprestidae (see Hawkeswood, 1978, for comments on this phenomenon). Moore and Brown (1985) further noted that „...the populations evolved autopotypically in the family [Buprestidae] but are being secondarily lost in Agrilini and Trachyini and perhaps in certain other advanced forms, where marked reductions in body size concomitant with specialized feeding habits has rendered them redundant.". I disagree that *Agrilus australasiae* is an advanced species because Volkovitsh & Hawkeswood (1990) found, on larval characters, that *A. australasiae* was more closely related to a primitive species group from the Northern Hemisphere than other groups. Also, although it is a moderately small buprestid, *A. australasiae* does not show any specialized feeding habits (either larval or adult) as do other small buprestids such as *Ethon* (Hawkeswood & Peterson, 1982; Volkovitsh & Hawkeswood, 1990). The poor development of buprestins in *A. australasiae* could be related to the fact that escape mechanisms and cryptic coloration are well developed, and these have been selected for over time, instead of the buprestins.

In the sample collections of adults from Hastings Point during 1987–1990, more males than females were collected. Whether this trend is apparent in all populations of the species must await further sampling. It is possible that those populations biased (skewed) towards males are better able to maintain high population levels through increased mate (female) location resulting in a higher percentage of females being fertilized during the breeding season.

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